SYSTEMS ANALYSIS AND THE CERTIFIED PUBLIC ACCOUNTANT

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December 1967

P-3739

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In preparing for this conference, I have viewed my task as looking for possible broadened roles for the CPA in that bright new automated world of the future. There are many possible directions that this broadened role might take, but by virtue of my association with RAND it is only natural for me to consider possible roles in support of planning activities.

RAND got involved in planning as a consequence of its research responsibilities to the United States Air Force which dates back about 20 years. This activity was given impetus in 1961 with the appearance on the scene of Mr. McNamara, closely followed by his comptroller-to-be, ex-RAND economist Charles J. Hitch. Their subsequent planning efforts in the Defense Department greatly expanded the use of analytical techniques which have been referred to, collectively, as systems analysis or the systems approach.

I'd now like to briefly describe for you what systems analysis attempts to accomplish in a planning situation. By a planning situation I mean one that requires a decision to be made now which may have a substantial impact on the future; as for example, a decision to buy a new house, a new missile, or a new business, all of which requires some kind of projection into the future.

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This paper was prepared for presentation at the 1967 Graduate Study Conference sponsored by the California CPA Foundation for Education and Research held at Stanford University, Stanford, California in August 1967.

I have also prepared two examples which I hope will illustrate one common technique we use in the systems approach called cost-effectiveness analysis.

First and most important to remember about systems analysis is that it cannot replace judgment, nor supplant the decisionmaker. Systems analysis strives to sharpen the judgment of the decisionmaker by providing him with insights he may not have had before the analysis was made. Its major purpose is first to set out, and then to illuminate, the major issues and alternatives involved in a planning situation.

Systems analysis at RAND involves establishing a study group or project, and then staffing it with analysts from some, or all, of our eleven departments. Typically, there would be included: engineers, social scientists, economists, operations analysts, and cost analysts. Our job is to work together as a team, and not as individuals, in addressing the problem and evaluating the possible solutions.

The virtue of working like this is that it permits the knowledge and judgment of experts in diverse fields to be combined in an orderly manner. This approach yields, at least in military areas, more valuable results than the sum of the results provided by each individual working alone.

The essence of the systems analysis method is to construct and operate within a model. A model is nothing more than a synthesis or representation of the real world. In any model we try to abstract the cause and effect relationships that are essential to the problems we have been asked to study. Such a model can take many forms, from simple mathematical relationships to a complex strategic war game. The trial balance that the accountants deal with is, in fact, a model of the financial transactions of a business.

The importance of this model cannot be overstated. It serves as a framework, and as a vehicle for communication both within the study group and between the study group and the outside world. The model should provide us with an idea of what we can expect from each alternative course of action contemplated. After designing and testing the model, the next step is to select a criterion which one can use in order to weigh the cost against the performance of each alternative.

The process of comparing alternatives on such a scale is called a cost-effectiveness analysis.

There are, in general, two conceptual approaches to making a cost-effectiveness analysis. The first is called a fixed-effectiveness approach, where, given a defined job to be done, an analysis is made to determine what alternative is likely to do it at the least cost. The second approach is called the fixed-cost approach, in which, given a cost or budget, an analysis is done to determine which alternative provides the best performance or highest effectiveness.

It would be naive to assume that major decisions are made exclusively on the numerical considerations of cost and effectiveness. The political aspects, social aspects, and the risk of success or failure of each alternative are practical and important inputs to any decision, and systems analysis is also expected to deal explicitly with these aspects of a problem. Cost-effectiveness analysis is therefore only one part of a systems analysis.

I have fabricated two examples which I hope will illustrate what cost-effectiveness analysis is in the context of a total systems analysis. Let's begin by looking at a military problem.

Let us assume that there is concern that within the next 10 to 15 years our overseas bases will be denied us because of changes in political leadership throughout the world. It is, therefore, suggested that we may need a fleet of new military transports which can take off and return to U.S. bases without having to stop for refueling. More specifically, it is suggested that these aircraft be nuclear powered.

The question for study is this: Under what conditions would such an aircraft appear attractive? How much will it cost to obtain and operate such a system? How does this cost compare with the cost of conventional airborne transport systems? What are the other factors (besides cost) which could affect the decision to design and develop such an aircraft?

We would first want to find out how the Military Airlift Command is currently operating, and how it may operate in the near future. Using this information, we would build a general military transport model within which we can formulate the alternative courses of action

we wish to compare. We would use the model to develop a method of estimating the cost and performance of each system of airlifting material. Next, we would combine cost and performance estimates into a meaningful cost-effectiveness scale. Finally, we would address ourselves to the "other" or non-quantifiable aspects of the problem. Figure 1 summarizes this procedure.

The results of the cost-effectiveness calculations are illustrated sequentially in Figs. 2 through 5. In Fig. 2, the cost per ton-mile (which is our cost-effectiveness scale) of cargo delivered is shown as a function of the roundtrip (unrefueled) distance. As the roundtrip distance increases, so does the cost per ton-mile because the payload of the aircraft has to be off-loaded and replaced by additional fuel required to fulfill the mission.

In a few years the air transport fleet will include a new Jumbo Jet aircraft (Boeing 747). In Fig. 3 we see a comparison of the cost per ton-mile of this aircraft with the present jet transport (707 type). Two conclusions may be drawn: A transport job which taxes the unrefueled capacity of the current jet can be done for less cost per ton-mile by the Jumbo Jet, or on the other hand at the same cost per ton-mile, a Jumbo Jet can add almost 5000 miles to the unrefueled range.

In Fig. 4, we have added a new alternative in which is provided an in-flight refueling capability for the Jumbo Jet, which extends its range.

Now let's look at how the cost of operating a fleet of nuclear powered aircraft might compare with these other alternatives. In Fig. 5, this comparison is illustrated. Since a nuclear powered aircraft could remain airborne almost indefinitely, the cost per ton-mile would not vary with the roundtrip distance. In theory, than, a nuclear aircraft could take off from its base in the U.S., deliver its cargo, and return without having to be refueled. Although the nuclear aircraft costs would be high, there appear to be some circumstances in which the cost of the conventional fueled jet aircraft would be as much as the cost of the nuclear aircraft.

MILITARY PROBLEM FOR SYSTEMS ANALYSIS

- PROBLEM — DENIAL OF OVERSEAS BASES
  DO WE NEED NUCLEAR POWERED AIRCRAFT ?
- MODEL — MILITARY AIRLIFT COMMAND - USAF
- COST-EFFECTIVENESS APPROACH — COST PER TON MILE OF CARGO DELIVERED
- OTHER CONSIDERATIONS — OTHER MILITARY MISSIONS
  DOMESTIC ECONOMY
  PUBLIC SAFETY
  INTERNATIONAL RELATIONS

FIG. 1

COST VS ROUND TRIP DISTANCE

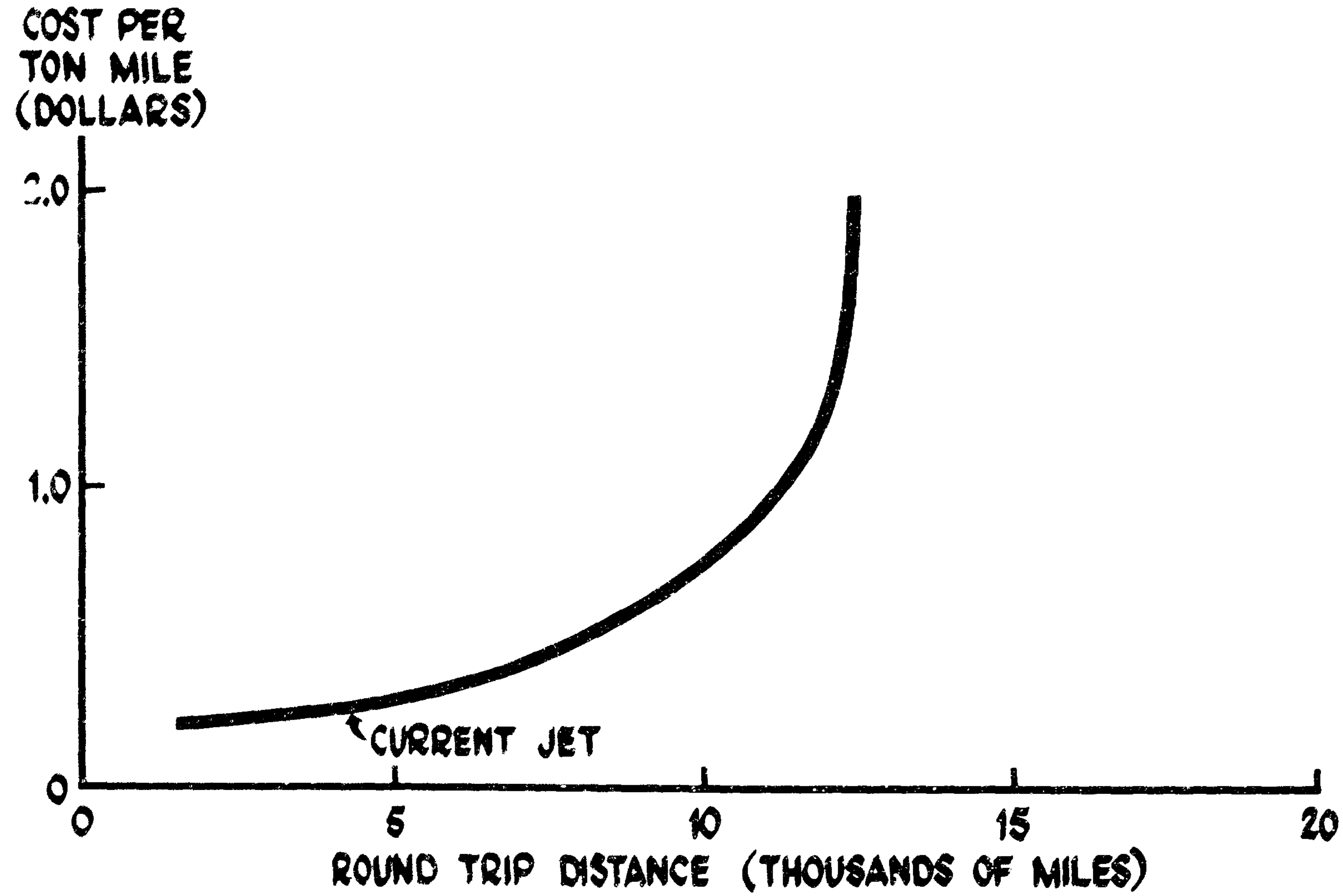

FIG. 2

COST VS ROUND TRIP DISTANCE

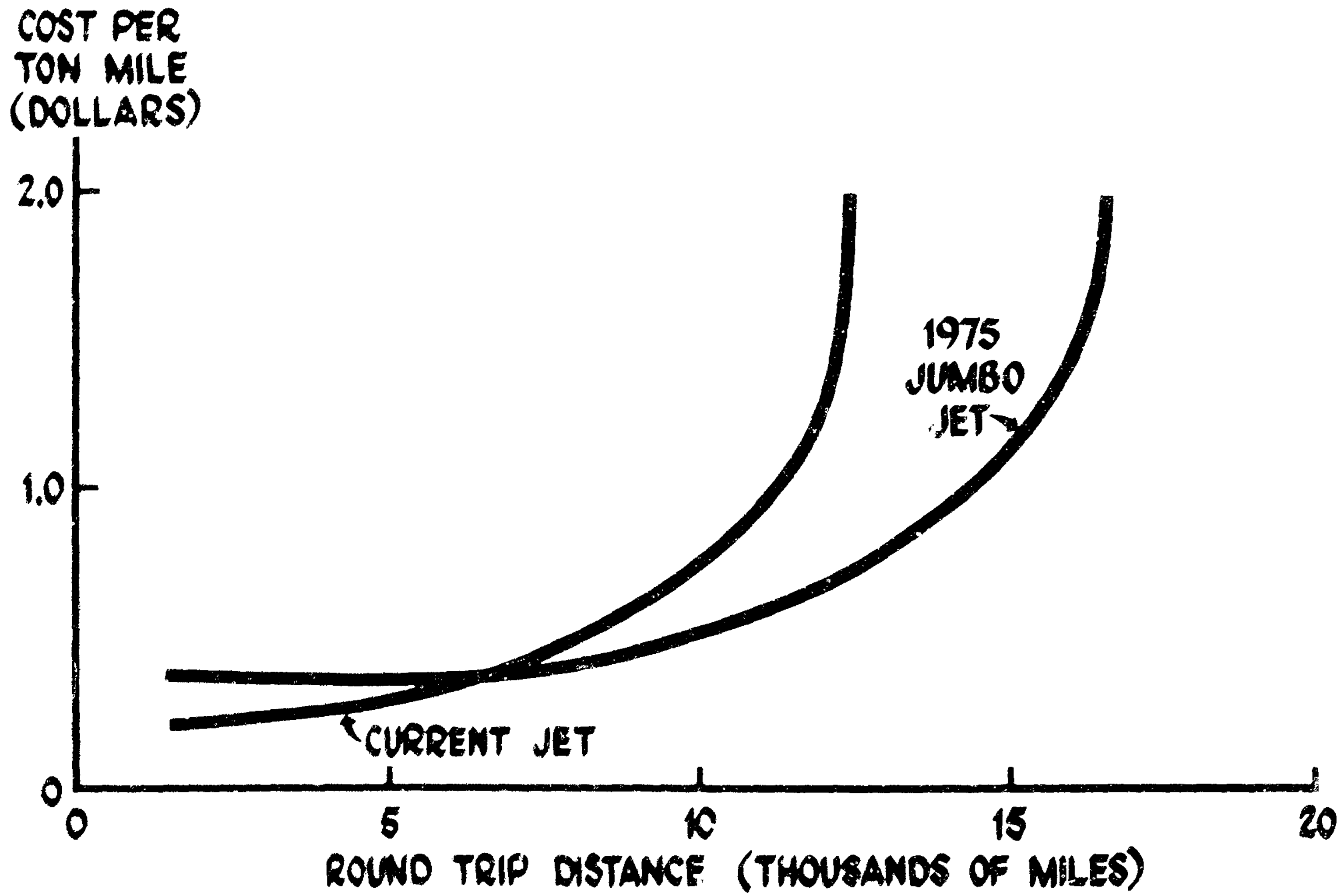

FIG. 3

COST VS ROUND TRIP DISTANCE

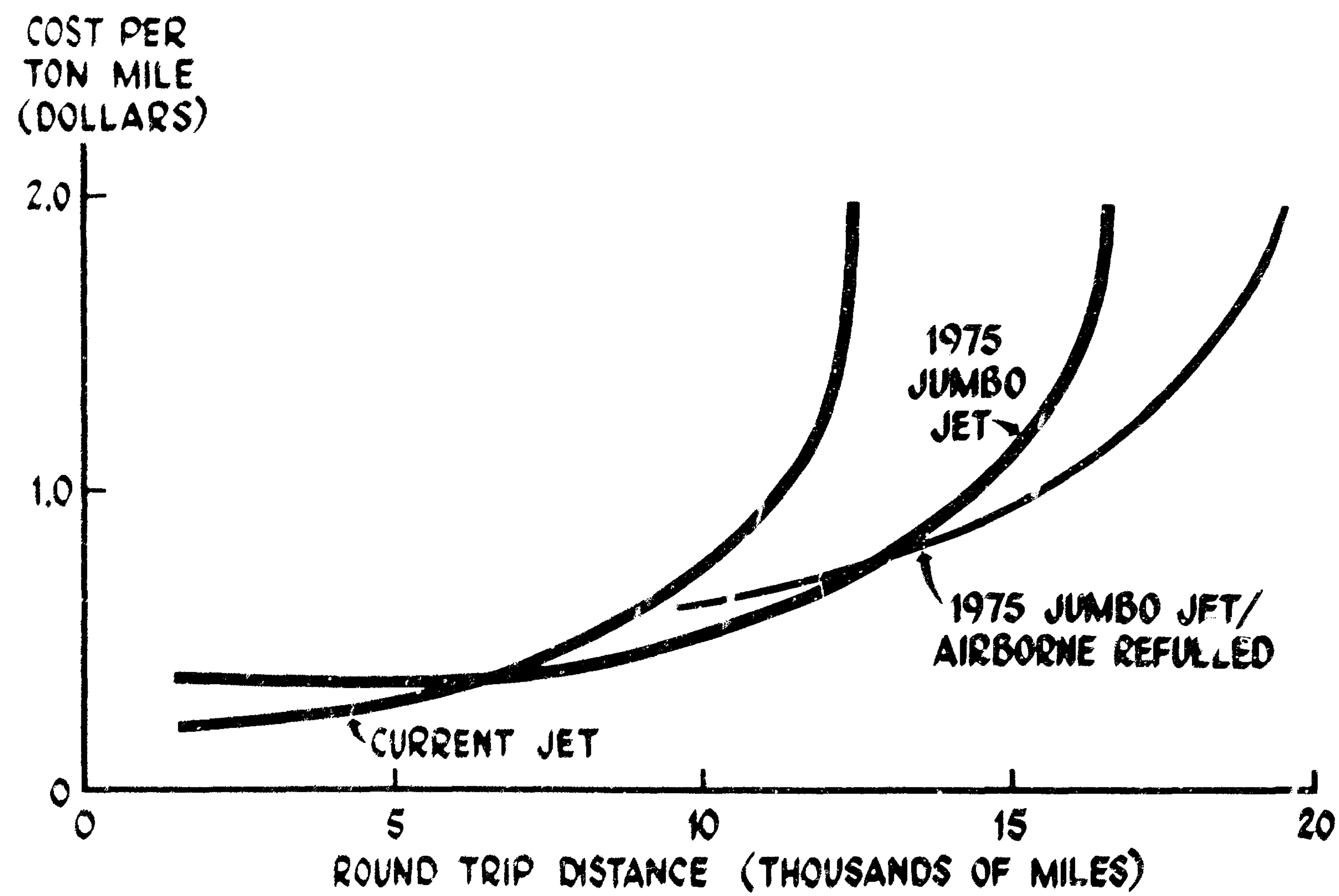

FIG. 4

COST VS ROUND TRIP DISTANCE

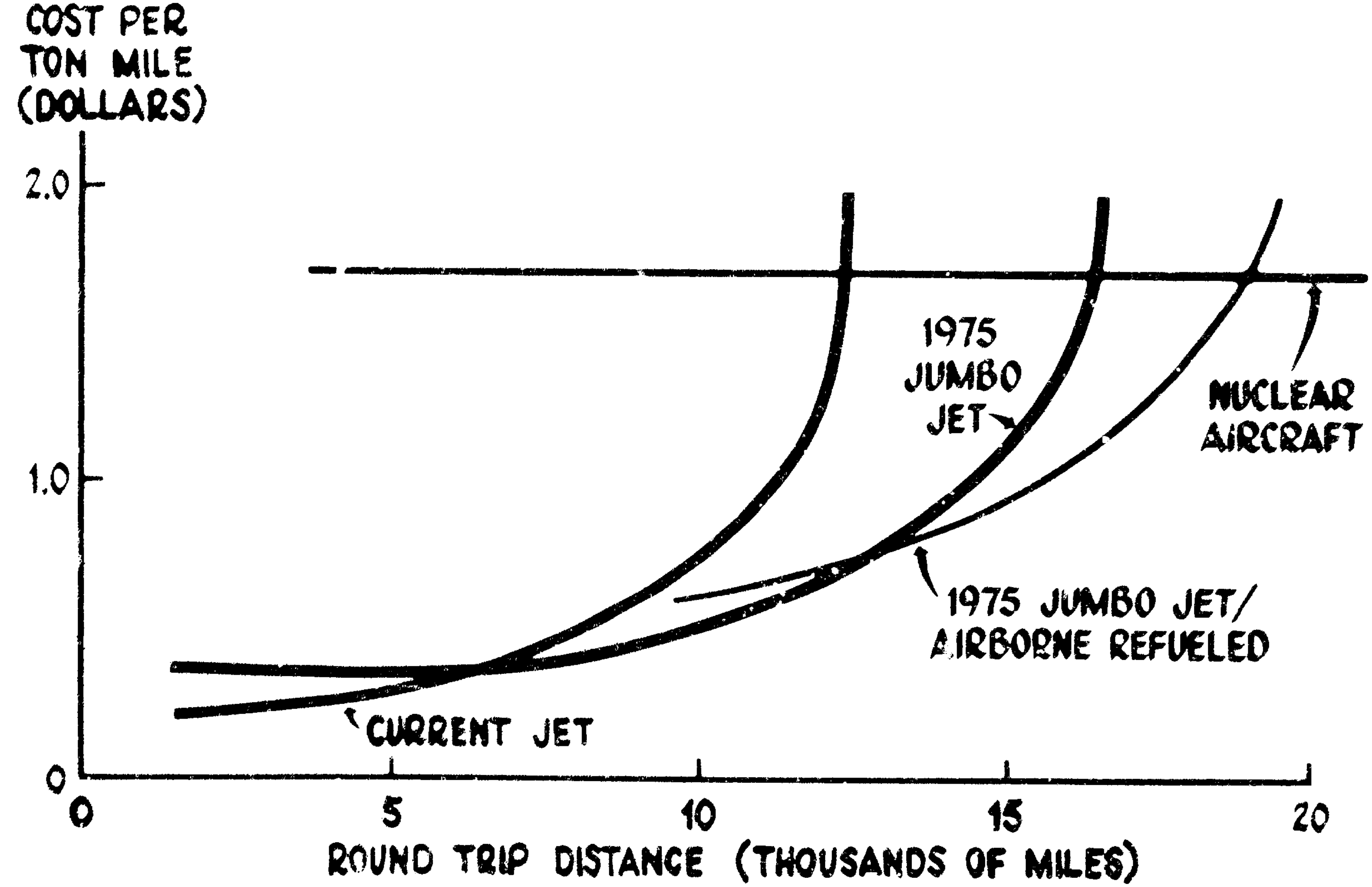

FIG. 5

Let us now turn to a nonmilitary example to see if an analogy can be drawn. Let's assume we are the accountants for the Palo Alto Taxi Company. They have just obtained a new franchise for Menlo Park which will permit operations to begin in 1968. Our problem is, what cab should the company buy for this new operation? In Fig. 6, this problem is set out.

Again, we would begin by building a generalized model of a cab company. We want to know how it operates and what the costs of operations are, so that we can estimate how the costs will change when we introduce the various cab alternatives into our model. In Fig. 7, there are shown the key system inputs to the model and the cost factors that we would need in order to estimate the cost of any alternative course of action.

"Base case" refers to the fact that we have described the existing operations and what these operations currently cost. The one variable parameter introduced is fleet size (since we are not sure how large a fleet we may need) and the overhead cost estimates which will change with the fleet size.

The cost of the base case is graphically shown in Fig. 8. The total cost of current operations is shown as a function of the number of cabs in the fleet. Total cost is defined as a 3-year life cycle cost. It includes procurement cost and 3 years of operations and maintenance cost. From this total cost presentation we can select those costs which will vary with the decision about which cab we should buy. The driver costs and overhead costs will not change, so we can set those aside for this analysis. The procurement, fuel, and maintenance may change and those we will call variable costs and look at these in more detail.

In Fig. 9, we have shown the variable costs for the base case cab (Ford) as well as for two alternative taxicabs which are initially higher priced but which may provide some cost advantage over an extended period of time. These alternatives are a Checker Cab, which is supposedly a heavy duty vehicle, and a Mercedes Diesel, whose diesel engine possesses lower maintenance and operating (fuel) cost. Figures 10 and 11

BUSINESS PROBLEM FOR SYSTEM ANALYSIS

- PROBLEM — NEW CAB FRANCHISE
  WHAT CAB TO BUY ?

- MODEL — PALO ALTO CAB CO - MENLO PARK DIVISION

- COST-EFFECTIVENESS APPROACH — GIVEN A DEMAND -
  MINIMIZE TOTAL COST

- OTHER CONSIDERATIONS — PUBLIC RESPONSE
  FUTURE LEGISLATION
  LOCAL POLITICS

FIG. 6

BASE CASE DESCRIPTION & COST

DESCRIPTION	COSTS
● FLEET SIZE — 10-40 CAB	OVERHEAD — \$100,000-\$150,000
● CAB — FORD FAIRLANE	DRIVER — \$4000/YR
● CAB LIFE — 3 YEARS	CAB — \$2500
● DRIVERS — 2 PER CAB	FUEL — 2.5 ¢/MILE
● UTILIZATION — 30,000 MILES/YR	MAINTENANCE 1.5 ¢/MILE
● MAINTENANCE POLICY — SAME	SYSTEM COST (3 YEARS)
	10 CABS — \$450,000
	40 CABS — \$1,530,000

FIG. 7

COST VS FLEET SIZE

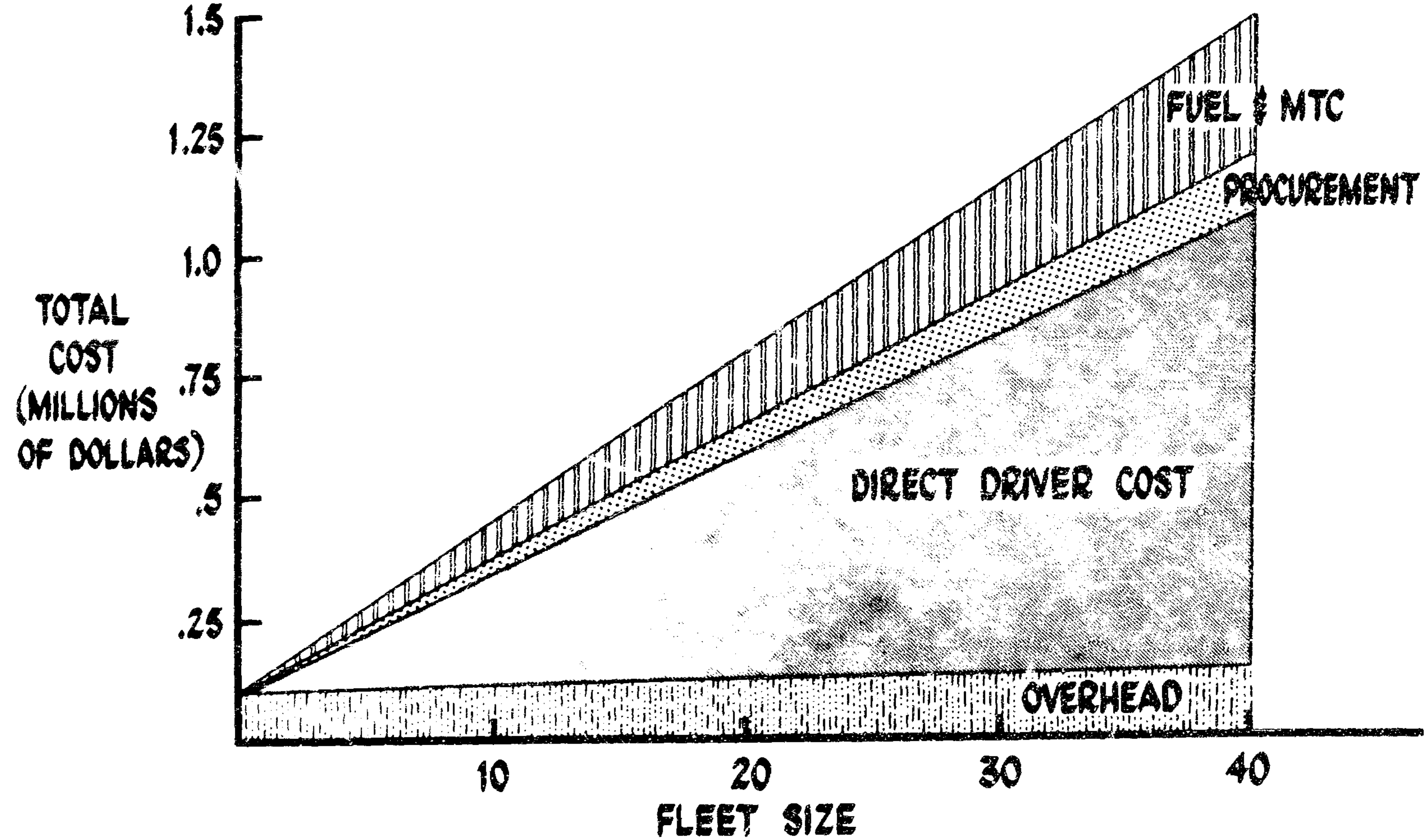

FIG. 8

VARIABLE COST FACTORS

COST ELEMENT	FORD	CHECKER	MERCEDES-DIESEL
PROCUREMENT ($)	2500	3000	4500
FUEL (¢/MILE)	2.5	2.5	1.0
MAINTENANCE (¢/MILE)			
3 YR LIFE	1.5	1.0	1.0
4 YR LIFE	2.0	1.2	1.1
5 YR LIFE	2.5	1.4	1.2

FIG. 9

show the kind of analysis which can be made based on the variable cost factors which were presented in Fig. 9. Figure 10 shows the variable cost for the three cab alternatives, as the cost would vary by the size of the fleet procured and operated for three years (as has been the custom in the past). It is obvious that from a cost standpoint it matters little which alternative is chosen. If, however, it is decided to operate the cabs for longer than three years, there are pronounced differences in variable cost for the three alternative cabs (as shown in Fig. 11).

In a like manner, we could vary each assumption, one at a time, and analyze the effect on the estimated costs. This activity is done frequently in a system study and is called cost-sensitivity analysis.

Again, let me say that a systems analysis is more than just cost-effectiveness and cost-sensitivity analysis. For example, for the cab company it may turn out that the diesel cab, which appears attractive in the cost-effectiveness analysis, may have to be ruled out because of expected smog legislation or lack of public acceptance. It may turn out that there is not adequate local maintenance available for the Checker cab, and that, if selected, it would require a new maintenance policy which could in turn result in higher maintenance cost and lower cab utilization.

I have addressed myself to the question: What is systems analysis and what does it try to accomplish in supporting the planning function? With the help of two simple examples, I have tried to illustrate the cost-effectiveness aspects of systems analysis. The next question to be addressed is then: What does this all mean to you and your role in tomorrow's business activities? First, in what kind of world can the accountant expect to find himself in the next few years? In a recent paper written by a computer expert at RAND, he listed a number of achievements he expected to take place in the 1970s. Among the eight he listed were the following four:

1. Information per se will be inexpensive and readily available.
2. Large and varied data banks will exist and be accessible to the public.

COST VS FLEET SIZE
(3 YR CAR LIFE)

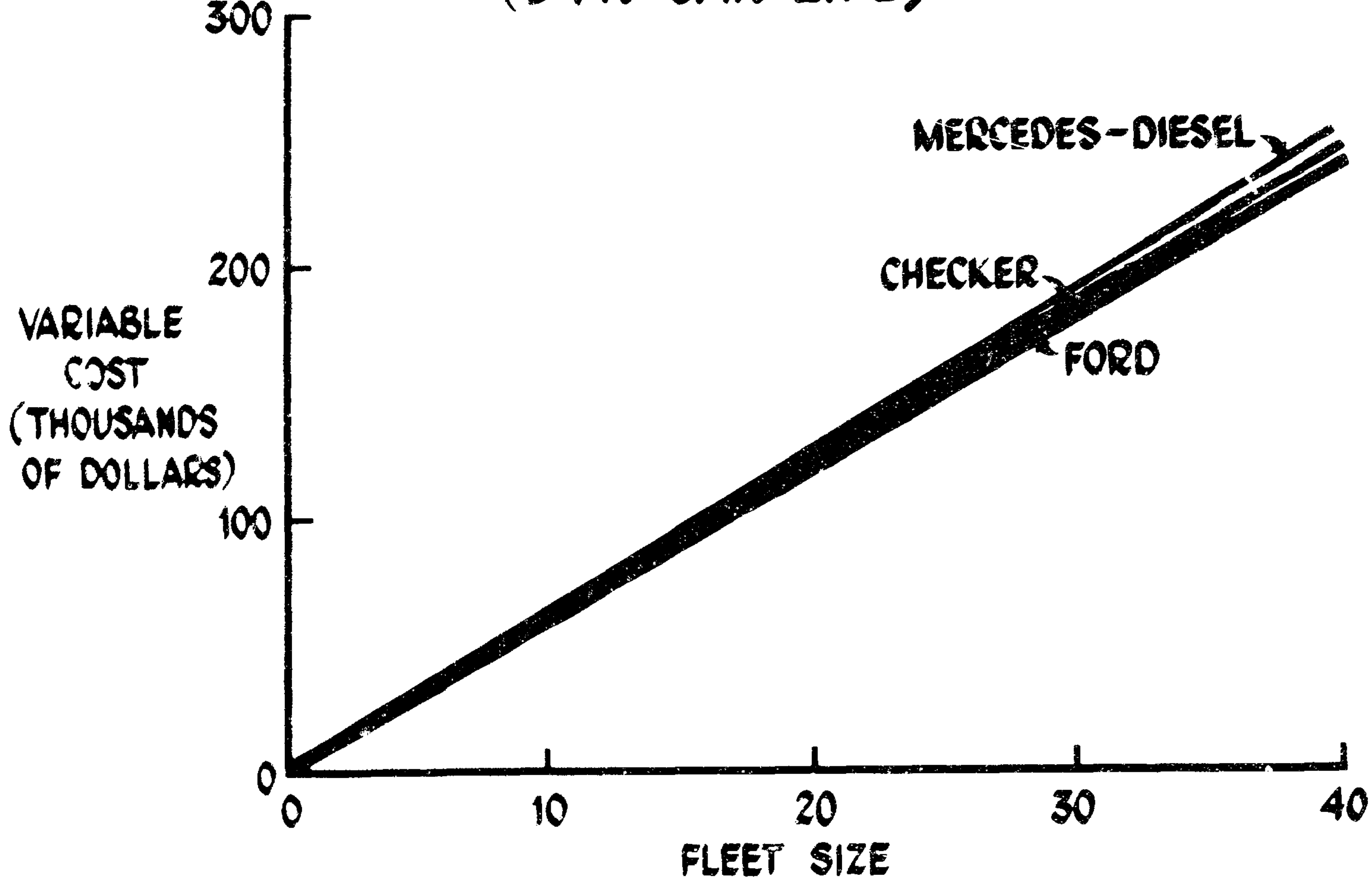

FIG. 10

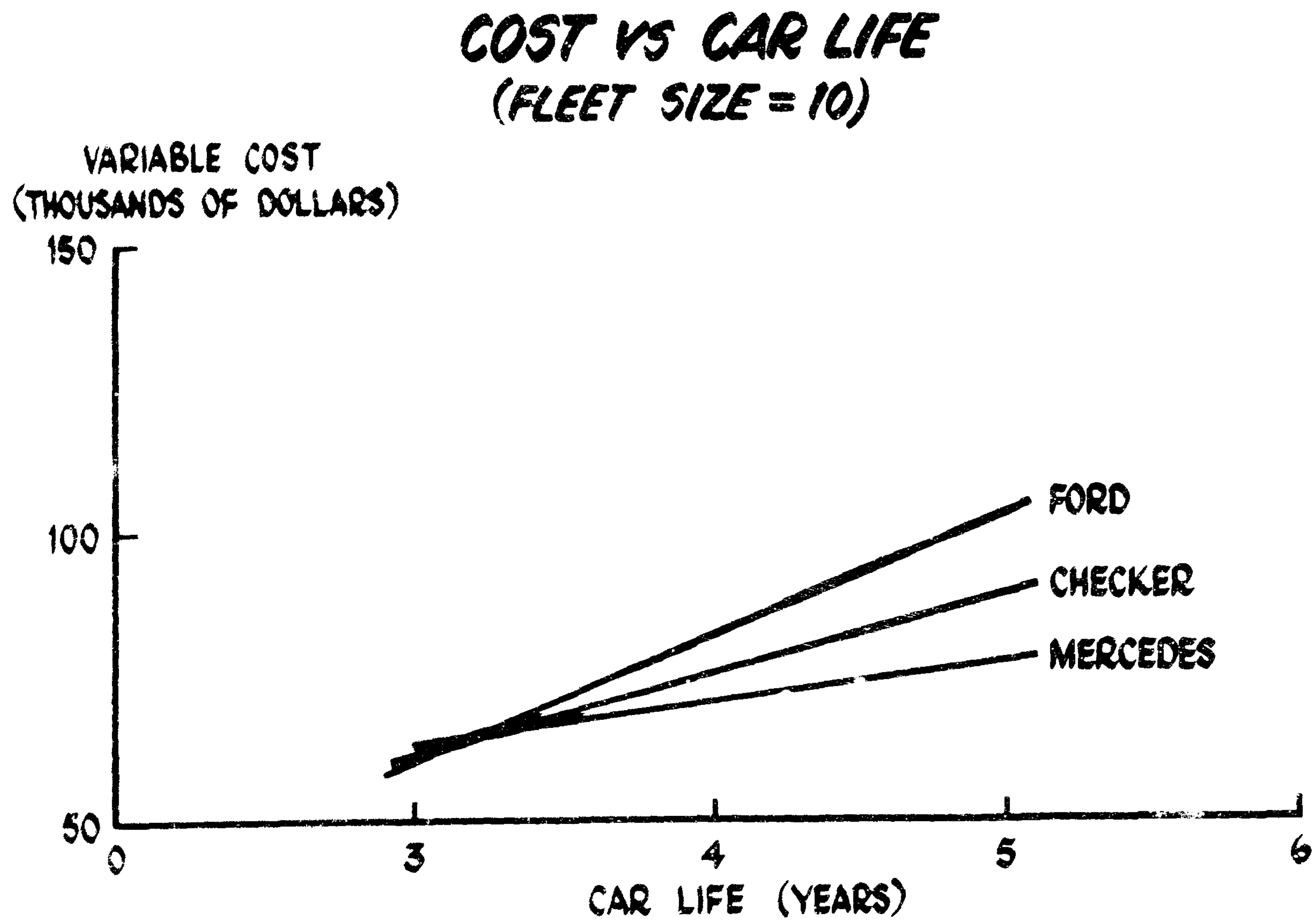
COST VS CAR LIFE
(FLEET SIZE = 10)
VARIABLE COST
(THOUSANDS OF DOLLARS)
150
100
50
0
3
4
5
6
CAR LIFE (YEARS)
FORD
CHECKER
MERCEDES

FIG. 11

3. Computers will be economically feasible for firms and activities of all sizes.
4. Computers will be used extensively in management science and decisionmaking.

I am currently involved in developing a new capability which uses an on-line time-sharing computer system to do cost analysis for military planning studies. In this system, cost estimates are made using a portable console which looks like a typewriter. It requires no card decks and there is no waiting time to get on the computer. The impact on cost (over a 10-year period) of changes in military programs can be estimated in from 2 to 10 minutes, depending on the number of input changes that are required to the program pre-stored in the computer. I think on-line computer systems of this kind will be widely used by management, both in government and eventually in private industry, to help make better decisions.

What few people seem to realize is that such a system requires a tremendous amount of data --data which must be properly collected, processed, analyzed and understood. Providing data is one area in which the CPA can contribute to better analysis and decisionmaking. Through his understanding of the relationships between operations and cost he can help in the design of a system which could supply the financial data needed to support the planning, control, or operating functions of a business.

Data system design for management is an important role. I feel, however, that the CPA has a more pressing job to do for his client, especially if the client is a small businessman. For the most part, small businesses can't afford large management consulting firms, but they do require and use the services of accounting firms. What I suggest is that the CPA with his knowledge and experience can and should help his client establish and use a systematic approach to planning and decisionmaking. The need for a financial data system can only be appreciated and the structure formulated after there is established the motivation for this systematic approach.